EAST AFRICAN COMMUNITY

# EDICT OF GOVERNMENT

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# EAST AFRICAN STANDARD

## Code of hygiene for transportation of edible fats and oils in bulk

# EAST AFRICAN COMMUNITY

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## Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in East Africa. It is envisaged that through harmonized standardization, trade barriers which are encountered when goods and services are exchanged within the Community will be removed.

In order to achieve this objective, the Partner States in the Community through their National Bureaux of Standards, have established an East African Standards Committee.

The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the private sectors and consumer organizations. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the procedures of the Community.

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

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# RECOMMENDED INTERNATIONAL CODE OF PRACTICE FOR THE STORAGE AND TRANSPORT OF EDIBLE FATS AND OILS IN BULK

**CAC/RCP 36 - 1987 (Rev.1-1999, Rev.2-2001, Rev.3-2005)**

## 1. SCOPE

This Code of Practice applies to the handling, storage and transport of all crude or processed edible oils and fats in bulk.

## 2. INTRODUCTION

### 2.1 General

Three types of deterioration can occur in oils and fats during the operations dealt with in this Code. The susceptibility of oils and fats to deterioration depends upon a number of factors including the type of oil or fat, whether it is crude, partially or fully refined and whether impurities are present. These should be considered when storing and transporting the oil.

#### 2.1.1 Oxidation

Contact of oils and fats with oxygen, present in the atmosphere, causes chemical changes in the product which downgrade the quality. Some of the effects of oxidation may be rectified within an edible oil refinery with some extra processing and, therefore, extra cost. However, the effects may be so severe that rectification is not possible.

Much can be gained by reducing the amount of air contact and this principle is the basis of several of the recommendations. Oxidation proceeds more rapidly as temperature increases, so each operation should be carried out at the lowest practicable temperature. The rate of oxidation is greatly increased by the catalytic action of copper or copper alloys, even when trace amounts (ppm) are present. Because of this, copper and copper alloys must be rigorously excluded from the systems. Other metals, such as iron, also have catalytic effects although less than that of copper.

#### 2.1.2 Hydrolysis

The breakdown of fats to fatty acids is promoted by the presence of water particularly at higher temperatures. Hydrolysis is also promoted by the action of certain micro-organisms. Tanks in which the oil is being stored or shipped should always be clean and dry before use.

#### 2.1.3 Contamination

Undesirable contamination may be from residues of a previous material handled in the equipment, dirt, rain, sea water or through the accidental addition of a different product. In storage installations and ships, particular difficulty may be experienced ensuring cleanliness of valves and pipelines, particularly where they are common for different tanks. Contamination is avoided by good design of the systems, adequate cleaning routines and an effective inspection service, and on ships by the carriage of oils in segregated tank systems in which the previous cargoes are included in the Codex List of Acceptable Previous Cargoes at Appendix 2 of this Code.

Contamination is also avoided by the rejection of tanks which have carried as a last cargo products which are included on the Codex List of Banned Immediate Previous Cargoes at Appendix 3 of this Code.

Previous cargoes not on the Codex Lists of Acceptable or Banned cargoes are only to be used if agreed upon by competent authorities of the importing countries.

Until both lists are completed, practitioners may find the lists and data referred to in the Bibliography at Appendix 4 provide relevant guidance.

## 3. STORAGE AND TRANSPORTATION

### 3.1 Tanks

3.1.1 Land Storage Tanks

The most suitable shape is the vertical, circular cross-section tank with self-supporting fixed roof, preferably conical in shape. Where possible, tall, narrow tanks are preferred to minimise the surface areas of the contents and, therefore, to minimise contact of the oils or fats with air and the oxygen it contains. Tank bottoms should be conical or sloped (with a sump) to facilitate draining.

All openings such as manholes, inlets, outlets, draining out points, etc., should be made such that they can be locked and/or effectively sealed.

For each installation, the total storage capacity, size and number of tanks need to be related to the size and frequency of intakes, rates of turnover and the number of different products handled etc.

3.1.2 Ships' Tanks

The economics of bulk transport requires that a range of cargoes can be carried on one vessel and tank capacities generally vary between 200 to 2,500 tonnes.

Ships tanks differ from land tanks and complete segregation of tanks is achieved by using individual pumps and line systems, each tank having its own dedicated pump and line system.

Mild steel tanks should preferably be coated to prevent attack or corrosion of the mild steel by the cargo. The coating should be approved for contact with food. The trend towards the use of stainless steel for tank construction will remove the need for tank coatings.

Damage to coatings can be caused by abrasion or by using unsuitable cleaning methods leading to local corrosion. The tanks should always be inspected before a cargo of oil or fat is loaded and, if necessary, repairs to the coatings should be carried out.

Ships employed in the trade tend to be categorised as follows:

(a) Bulk Tankers:

These range from 15,000 to 40,000 tonnes and have a varying number of different sized tanks, usually with inter-connected valves. They are best suited for the carriage of single oils, in large volumes, where they can be loaded with valves open for fast receipt of the cargo and easier trim of the vessel.

(b) Parcel Tankers:

These are more sophisticated ships, mainly in the 15,000 to 40,000 tonne range, designed to carry a variety of different but fully segregated bulk liquids. Each tank may have one of a number of different coatings to suit a particular kind of cargo and each tank, or small group of tanks, will have its own dedicated pipelines and pumps.

(c) Coasters:

The classes of vessel referred to above are ocean going ships that service the major ports of loading and discharge. In addition, there are many small coasters, generally between 750 and 3,000 tonnes, that cover short sea voyages. They are also frequently used to handle transhipment from ocean-going vessels.

(d) Container Vessels:

As the name implies, these ships are purpose built to carry containers of uniform dimensions for convenient stowage. They ply between container terminals, whilst the containers themselves can be filled and unloaded at whatever other, frequently inland, point/s may best suit the goods and parties concerned.

3.1.3 Road and Rail Tankers and Bulk Liquid Containers (ISO Tank Containers)

Road and rail tankers and bulk liquid containers (ISO tank containers) used to transport oils and fats overland. Where the oils and fats are fully refined and deodorised for direct human consumption, the tank is normally of stainless steel construction or mild steel coated with epoxy resin.

3.1.4 Materials

(a) All materials used in the construction of tanks and for ancillary equipment (including heating facilities) should be inert to oils and fats, and should be suitable for use in contact with food.

(b) Stainless steel is the most preferred metal for the construction of tanks. It is particularly recommended for the storage and transport of fully refined oils and fats. Tanks of mild steel should preferably be coated with an inert material on the inside, for example phenolic epoxy resins. Their suitability for contact with foodstuffs, particularly oils and fats, should be obtained from coating manufacturers. Zinc silicate coatings for mild steel tanks are also suitable, but it should be noted that deterioration of the oil can take place if used with crude oils and fats with high acid values.

Prior to application of the coating, the metal surface must be sand-blasted to bright metal (ISO 8501-1: 1988) or equivalent. It should be noted that there are temperature limitations on many coatings which must be carefully observed particularly during the cleaning of the tank (for example, the temperature limitation may preclude the use of live steam in the cleaning operation).

(c) Copper and its alloys such as brass, bronze or gun metal should not be used in the construction of the storage installation or in a ship or road/rail tanker used for transport that has contact with the oils or fats such as piping, pipe connections, seals, valves, heating coils, strainers, pumps, temperature gauges or in sampling apparatus. Temperature gauges containing mercury should not be used.

Glass equipment and glass sample bottles should be avoided in situations where breakage might lead to contamination.

3.1.5 Heating Facilities - Tanks

All tanks for solid, semi-solid and high viscosity oils and fats should be installed with heating facilities (see also Section 3.1.7) so that the product is liquid and homogenous when transferred or unloaded. Heating coils should be of stainless steel construction. Heating coils constructed from alloys containing copper are not suitable.

Use of means of heating should be by design, construction and procedures, such as to avoid contamination and damage to the oil. Suitable means of heating are as follows:

(a) Bare Hot Water Pipes

Heating by hot water (about 80°C) circulated through coils is the best procedure because it is least likely to cause local overheating. Coils should be self draining or mechanical or vacuum pump draining.

(b) Bare Steam Pipes

Heating by steam with pressure up to 150 kPa (1.5 bars) gauge (temperature of 127°C) can also be used. Coils should be self draining or mechanical or vacuum pump draining.

The heating coils should rest on supporting legs about 7.5 cm (3") above the base of the tank. Some operators prefer supporting legs 15 cm (6") or 30 cm (12") high (to facilitate cleaning and to improve heat transfer to the oil). Vertical hairpin coils or side heating coils installed on the tank walls should also be provided. As a guide a coil area of about 0.1 $m^2$/tonne of tank capacity is required if the fat has to be melted, but 0.05$m^2$/tonne suffices for heating-up purposes. The total coil length is normally divided into two or more separate coils, of a length suitable to avoid excessive accumulation of steam condensate.

(c) External Heat Exchangers

These provide uniform heating and may be used as an alternative to other heating systems in cases where the product is required to remain liquid and pumpable in the tank.

External heat exchangers should satisfy the requirements of all means of heating with respect to design and construction such as to avoid contamination and damage to the oil. There should be procedures in place to detect incidents of leakage should they occur.

Although hot water and steam are the preferred means of heating, other substances may be used on the basis of safety and risk evaluation and inspection procedures. Upon request by the competent authorities, evidence may be required to demonstrate that the heating media employed have been properly evaluated and safely used.

3.1.6 Heating Facilities - Road and Rail Tankers and ISO Tank Containers

For solid or semi-solid fats and high viscosity oils, road and rail tankers and ISO tank containers where fitted with internal heating coils, these should be of stainless steel which can be coupled to a source of hot water or low pressure steam (pressure up to 150 kPa (1.5 bars) gauge).

3.1.7 Storage tank and Road/Rail Tanker Insulation

Storage tanks, tankers and containers should preferably be insulated, particularly in temperate and cold climates. Insulation is usually fitted externally and must be designed to avoid the absorption of oil or water. Insulation material should be impervious to oils and fats.

3.1.8 Control of Temperature

All ships and storage tanks with heating facilities should be equipped with temperature sensors and control devices to prevent overheating of oil in the tank and associated lines. Thermometers must be carefully sited and away from heating coils. It is useful to have automatic recording type thermometers to provide records of temperature control. The recorder should be installed in a conspicuous location such as the supervisor's office or the ship's operations room.

3.1.9 Protection from Aeration

Pipelines and their connections should be designed so that admixture with air is avoided. Filling can be done from the bottom or over the top of the tank with the pipe leading to near the bottom to avoid cascading to prevent aeration. It is preferable to clear the pipe line leading to the tank by a "pigging" system and/or by the use of inert gas. However, if air is used a suitable means must be provided to prevent it being blown into the oil in the tanks.

3.1.10 Inert Gas Protection

Ships and storage tanks used for high quality products or for long storage periods should preferably have facilities for sparging and blanketing with inert gas of appropriate purity.

**3.2 Pipelines**

3.2.1 Materials

Mild steel is acceptable for all crude and semi-refined oils and fats though stainless steel is preferable. Stainless steel should be used for fully refined products. (see also 3.1.4 c)

3.2.2 Flexible Hoses

All flexible hoses used to connect pipelines during loading and unloading must be of inert material, be suitably reinforced and be of such a length to make cleaning easy. Exposed ends should be capped when not in use. Couplings should be of stainless steel or other inert materials.

3.2.3 Insulation and Heating

In temperate and cold climates, pipelines used for oils and fats which may solidify at ambient temperatures should preferably be lagged and also provided with heating, for example by steam tracing lines or electrical heating tape. When clearing pipelines in such climates, steam may be used.

## 4. OPERATIONS

### 4.1 Loading and Unloading

4.1.1 Heating up

Before transfer, solid, semi-solid and high viscosity oils and fats in storage tanks, shore tanks, ship tanks and road and rail tank cars should be heated slowly so that they are liquid and completely homogeneous. Heating should start at a time calculated to give the required pumping temperature without ever exceeding the maximum rate of 5°C over a 24 hour period. If steam is used, the steam pressure should not exceed 150 kPa (1.5 bars) gauge to prevent localised over-heating. The coils should be covered completely before heating of the tank begins.

4.1.2 Temperatures During Storage and Transport

To prevent excessive crystallisation and solidification during short-term storage and shipping, oil in bulk tanks should be maintained within the temperature ranges given in Table 1.

The temperatures apply to both crude and refined oils in each grade.

The temperatures are chosen to minimise damage to the oil or fat. Some crystallisation will occur, but not so much as to require excessively long heating before delivery. Thus palm oil stored at 32°C - 40°C will require about three days heating at 5°C over a 24 hour period to bring it to transfer temperature. Long term storage of all soft oils should be at ambient temperature and heating should be completely turned off. If the oil then becomes solid, extreme care should be taken during the initial heating to ensure that localised overheating does not occur.

4.1.3 Temperature During Loading and Discharge

The various oil products should be heated up to the temperature shown in Table 1 before transfer.

The lower temperatures apply to low melting point grades, while the higher temperatures are necessary for higher melting point grades. The temperatures apply to both crude and refined oils in each type.

Temperature at loading or unloading should refer to the average of top, middle and bottom temperature readings. Readings should be taken not less than 30 cm away from the heating coils.

Under cold weather conditions discharge temperatures should be at the maximum of those shown in Table 1, to prevent blocking of unheated pipelines.

4.1.4 Loading and Unloading Sequence

Different oils and grades should be kept separate and pumping “new” oil into “old” oil in particular should be avoided for oxidative quality reasons. It is preferable to transfer different oils and grades through segregated lines.

Where a number of products are transferred through a common pipeline system, the system must be cleared completely between different products or grades. The order of loading and discharge should be carefully chosen to minimise adulteration.

The following principles should be observed:

- Fully refined oils before partly refined.
- Partly refined oils before crude oils.
- Edible oils before technical grades.
- Fatty acids or acid oils should be pumped last.
- Special care should be taken to prevent adulteration between lauric oils and non-lauric oils.

4.1.5 The first pumpings of each grade should be collected where possible in separate tanks for quality checks.

### 4.2 Cleaning

In addition to what has been said above, where tanks have been used for non-edible materials, the greatest care must be taken by cleaning and inspection that all residues have been totally removed.

If steam or water are used for cleaning, the system must be drained and completely dried before oil is handled. A pipeline “pigging” system should be provided at each storage installation. If detergents or alkali are used, all surfaces with which they have been in contact should be rinsed thoroughly with fresh water to ensure that no residues remain.

### 4.3 Maintenance

Regular maintenance checks should be made, preferably as part of a properly planned maintenance programme. They should include functioning of steam pressure regulation valves; all steam supply valves and steam traps for leakage; thermometers, thermostats, recording thermometers, weighing equipment and any gauge meters for function and accuracy; all pumps regulated by thermostat for leakage; integrity of tank coatings; hoses (internal and external) and condition of tanks and ancillary equipment.

### 4.4 Others

4.4.1 There must be clear marking or identification systems for the pipelines and storage tanks.

4.4.2 The condition such as cleanliness of storage tanks, road tankers, ship's tanks and pipelines should be inspected by a suitably qualified superintendent for every loading or unloading of oil and written reports provided.

4.4.3 The receiver may wish to keep tank sediments separate from the bulk.

4.4.4 Records of the ship's heating log should be provided.

4.4.5 Ship loading samples, properly marked and sealed, should be delivered as required by the contract.

4.4.6 The three previous cargoes carried in a ship's tank should be declared to the charterer and the records made available to all parties involved. The provision should be part of all shipping contracts. In addition, authorities may wish to see evidence of previous cargo details.

**APPENDIX 1**

**TABLE 1**

**TEMPERATURES DURING STORAGE, TRANSPORT, LOADING AND DISCHARGE**

| | **Storage and bulk shipments** | | **Loading and Discharge** | |
|---|---|---|---|---|
| **Oil or fat** | **Min °C** | **Max °C** | **Min °C** | **Max °C** |
| Castor oil | 20 | 25 | 30 | 35 |
| Coconut oil | 27 | 32 | 40 (1) | 45 (1) |
| Cottonseed oil | Ambient | Ambient | 20 | 25 (4) |
| Fish oil | 20 | 25 | 25 | 30 |
| Grapeseed oil | Ambient | Ambient | 10 | 20 (4) |
| Groundnut oil | Ambient | Ambient | 20 | 25 (4) |
| Hydrogenated oils | Various | - | Various | - (2) |
| Illipe butter | 38 | 41 | 50 | 55 |
| Lard | 40 | 45 | 50 | 55 |
| Linseed oil | Ambient | Ambient | 10 | 20 (4) |
| Maize (corn) oil | Ambient | Ambient | 10 | 20 (4) |
| Olive oil | Ambient | Ambient | 10 | 20 (4) |
| Palm oil | 32 | 40 | 50 | 55 |
| Palm olein | 25 | 30 | 32 | 35 |
| Palm stearin | 40 | 45 | 60 | 70 (3) |
| Palm kernel oil | 27 | 32 | 40 (1) | 45 (1) |
| Palm kernel olein | 25 | 30 | 30 | 35 |
| Palm kernel stearin | 32 | 38 | 40 | 45 |
| Rapeseed/low erucic acid rapeseed oil | Ambient | Ambient | 10 | 20 (4) |
| Safflower oil | Ambient | Ambient | 10 | 20 (4) |
| Sesame oil | Ambient | Ambient | 10 | 20 (4) |
| Sheanut butter | 38 | 41 | 50 | 55 |
| Soyabean oil | Ambient | Ambient | 20 | 25 (4) |
| Sunflower oil | Ambient | Ambient | 10 | 20 (4) |
| Tallow (for voyages of 10 days or less) | Ambient | Ambient | 55 | 65 |
| Tallow (for voyages of more than 10 days) | 35 | 45 | 55 | 65 |

**Notes**

(1) For warmer climates, the loading and discharge temperatures for coconut oil and palm kernel oil are Min 30°C, Max 39°C or ambient temperature.

(2) Hydrogenated oils can vary considerably in their slip melting points, which should always be declared. It is recommended that during the voyage, the temperature should be maintained at around the declared melting point and that this should be increased prior to discharge to give a temperature of between 10° C and 15°C above that point to effect a clean discharge.

(3) Different grades of palm stearin may have wide variations in their slip melting points and the temperature quoted may need to be adjusted to suit specific circumstances.

(4) It is recognised that in some cases the ambient temperatures may exceed the recommended maximum figures shown in the Table.

**APPENDIX 2**

## CODEX LIST OF ACCEPTABLE PREVIOUS CARGOES

[To be developed.]

**APPENDIX 3**

## CODEX LIST OF BANNED IMMEDIATE PREVIOUS CARGOES

**Notes**

(1) Cargoes not included in the list are only acceptable if they are agreed upon by the competent authorities of the importing country (see section 2.1.3 of the Code).

**List of banned immediate previous cargoes**

| Substance (synonyms in brackets) | CAS number |
|---|---|
| Acetone cyanohydrin (ACH; α-hydroxyisobutyronitrile; 2-methyllactonitrile) | 75-86-5 |
| Acrylic acid (acroleic acid; propenoic acid) | 79-10-7 |
| Acrylonitrile (ACN; 2-propenenitrile; vinyl cyanide) | 107-13-1 |
| Adiponitrile (1,4-dicyanobutane) | 111-69-3 |
| Aniline (phenylamine; aminobenzene) | 62-53-3 |
| Benzene | 71-43-2 |
| 1,3-Butadiene (vinylethylene) | 106-99-0 |
| n-Butylacrylate | 141-32-2 |
| tert-Butylacrylate | 1663-39-4 |
| Carbon tetrachloride (CTC; tetrachloromethane; perchloromethane) | 56-23-5 |
| Cardura E (tradename for glycidyl esters of versatic 911 acid) | 11120-34-6 |
| Cashew nut shell oil (CNSL; cashew nut shell liquid) | 8007-24-7 |
| Chloroform (TCM) | 67-66-3 |
| Cresol - ortho, meta, para (cresylic acid) | 95-48-7<br>108-39-4<br>106-44-5 |
| Dibutylamine | 111-92-2 |
| Diethanolamine (DEA; di-2-hydroxyethylamine) | 111-42-2 |
| Diethylenetriamine | 111-40-2 |
| Diglycidylether of bisphenol A | 1675-54-3 |
| Di-isopropylamine | 110-97-4 |
| Dipropylamine | 108-18-9 |
| m-Divinylbenzene (DVB; vinyl styrene) | 1324-74-0 |
| Epichlorohydrin (chloropropylene oxide; EPI) | 106-89-8 |
| Epoxy resins (uncured) | |
| Ethyl acrylate | 140-88-5 |
| Ethylene dibromide (EDB; 1,2-dibromoethane; ethylene bromide) | 106-93-4 |
| Ethylene dichloride (EDC; 1,2-dichloroethane; ethylene chloride) * | 107-06-2 |
| Ethylene glycol (MEG; monoethylene glycol) | 107-21-1 |
| Ethylene glycol monobutyl ether (2-butoxyethanol) | 111-76-2 |
| Ethylene oxide (E0) | 75-21-8 |
| 2-Ethylhexyl acrylate | 103-11-7 |

| **Substance (synonyms in brackets)** | **CAS number** |
|---|---|
| Ethanolamine (MEA; monoethanolamine; colamine; 2-aminoethanol; 2-hydroxyethylamine) | 141-43-5 |
| Ethylenediamine (1,2-diaminoethane) | 107-15-3 |
| Formaldehyde | 50-00-0 |
| Furfuryl alcohol (furyl carbinol) | 98-00-0 |
| Glutaraldehyde | 111-30-8 |
| Hexamethylenediamine (1,6-diaminohexane; 1,6-hexanediamine) | 124-09-4 |
| Isocyanates<br>These include for example: | |
| Toluene di-isocyanate (TDI) | 1321-38-6 |
| Polyphenyl polymethylene isocyanate (PAPI, PMPPI) | 9016-87-9 |
| Di-phenyl methane di-isocyanate (MDI) | 101-68-8 |
| Methyl isocyanate | 624-83-9 |
| Methylene diisocyanate (diisocyanatomethane) | 4747-90-4 |
| Leaded products (shall not be carried as three previous cargoes) | |
| Lube oil additives | |
| Methyl acrylate | 96-33-3 |
| Methyl methacrylate monomer | 80-62-6 |
| Methyl styrene monomer (vinyl toluene) | 25013-15-4 |
| α Methyl styrene monomer (AMS) | 98-83-9 |
| ρ Methyl styrene monomer (PMS) | 622-97-9 |
| Methylene chloride (MEC; dichloromethane; methylene dichloride) | 75-09-2 |
| Monoethylene glycol (MEG; ethylene glycol) | 107-21-1 |
| Morpholine | 110-91-8 |
| Morpholine ethanol (N-hydroxyethyl morpholine) | 622-40-2 |
| Nitric acid (aqua fortis; engravers acid; azotic acid) | 7697-37-2 |
| Nitropropane (1 isomers and mixtures)<br>(2 isomers and mixtures) | 108-03-2<br>79-46-9 |
| Perchloroethylene (PEC) | |
| Phthalates<br>(These include - | |
| Di-allyl phthalate (DAP) | 131-17-9 |
| Di-isodecyl phthalate (DIDP) | 19269-67-1 |
| Di-isononyl phthalate (DINP) | 68515-48-0 |
| Di-isooctyl phthalate (DIOP) | 27554-26-3 |
| Di-octyl phthalate (DOP) | 117-81-7 |
| n-Propylamine | 622-80-0 |
| Propylene oxide (methyl oxirane; 1,2-epoxypropane) | 75-56-9 |
| Pyridine | 110-86-1 |
| Styrene monomer (vinyl benzene; phenyl ethylene; cinnamene) * | 100-42-5 |
| Tall oil | 8002-26-4 |
| Tall oil fatty acid equivalent to ASTM TYPE III | 61790-12-3 |
| Telone II (1-propene, 1,3-dichloro; 1,3-dichloropropene) | |
| Toluene | |
| Toluidine (ortho) | |
| Transformer oils of PCB type ( e.g. trichlorobiphenyl) | 25323-29-2 |

| **Substance (synonyms in brackets)** | **CAS number** |
|---|---|
| Trichloroethane (1,1,1- and 1,1,2-isomers) | |
| Triethylene glycol (TEG) | |
| Vinyl acetate monomer (VAM) | |
| Vinyl chloride monomer | 75-01-4 |
| Xylene (ortho, meta, para) | |

* Banned as any one of the last two cargoes in organically coated tanks and as the last cargo in stainless steel and inorganically coated tanks.

**APPENDIX 4**

## BIBLIOGRAPHY

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